

UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BERKELEY, CALIFORNIA

The Harvesting and Handling of Fall and Winter Pears

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BULLETIN 533

June, 1932

UNIVERSITY OF CALIFORNIA PRINTING OFFICE
BERKELEY, CALIFORNIA

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THE HARVESTING AND HANDLING OF FALL AND WINTER PEARS¹

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Besides the Bartlett pear, for the most part maturing in July and August, there are some dozen varieties of commercial importance known generally as "fall and winter" pears. Certain of these are not harvested until several weeks after the Bartlett and are held in storage for a number of months. On the other hand the Hardy, now shipped in larger quantity than the well-known Winter Nelis, is harvested and often marketed during the Bartlett season, which by means of cold storage, may easily be extended until November. Thus while common usage designates as "fall and winter" or "late" pears those harvested immediately after the Bartlett or even concurrently, such terms do not always indicate that these varieties are really consumed later than the Bartlett.

A previous Experiment Station publication³ has presented data secured on the harvesting of Bartlett pears. The present bulletin continues the study with the later-ripening varieties, grown primarily in the Santa Clara and other coastal valleys but now becoming more important than formerly in certain Bartlett pear districts.

GENERAL HARVESTING AND HANDLING PRACTICES

Most orchards of fall and winter pears contain several varieties, varying in season from the Hardy (Beurre Hardy), maturing in early August, to Easter Beurre, harvested in September and October. Having once begun, growers wish to continue their harvesting and handling operations with the different pears uninterrupted. The demand of the trade for certain varieties on a given date, the seasonal variation in sizing and ripening, and the locality of the orchard are important factors influencing the time and order of harvesting. Table 1 will serve as a general calendar of harvesting in the Santa Clara Valley.

¹ Received for publication June 23, 1932.

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³ Allen, F. W. Maturity standards for harvesting Bartlett pears for eastern shipment. California Agr. Exp. Sta. Bul. 470:1-27. 1929.

Picking dates in the Carmel and Soledad districts average from two weeks to a month later. In the Sacramento Valley and Sierra foothill districts, pickings of the more important varieties fall within the range of dates given for the Santa Clara Valley.

TABLE 1
AVERAGE PICKING DATES OF FALL AND WINTER PEARS FOR THE
SANTA CLARA VALLEY*

Variety	Dates of initial pickings	Dates of last pickings
Hardy.....	July 20 to August 5.....	August 15 to September 1
Bosc.....	August 5 to August 20.....	August 25 to September 10
Clairgeau.....	August 5 to August 20.....	August 25 to September 10
Comice.....	August 10 to August 25.....	August 30 to September 15
Anjou.....	August 10 to August 25.....	August 30 to September 15
Forelle.....	August 10 to August 25.....	August 20 to September 5
Glou Morceau.....	August 25 to September 5.....	September 15 to September 25
Winter Nelis.....	September 1 to September 20.....	September 20 to October 10
P. Barry.....	September 1 to September 20.....	September 20 to October 10
Easter Beurre.....	September 15 to October 1.....	October 1 to October 15

* Courtesy of the Santa Clara Pear Association.

As a rule, growers wish to start harvesting the earlier varieties as soon as suitably mature, in order to fill early orders and to keep ahead of the later-ripening sorts. Calendar dates, the size and color of the fruit, and the ease of separation from the spur all determine the time of picking. In addition, the pressure tester, which shows changes in firmness, is becoming generally recognized as a valuable aid in determining maturity.

Whether the entire crop of a tree or block of trees is picked at one, two, or even three pickings, depends largely upon the variety and uniformity of ripening, and the current market demands. The harvesting of pears shipped in relatively small quantities, such as Howell, Forelle, and Seckel, is usually completed in one picking. The same practice is also most general with the late-ripening varieties such as Winter Nelis, Glou Morceau, P. Barry, and Easter Beurre, although with Winter Nelis, early export orders, an unusually large crop, or slow and irregular sizing may make two or even three pickings desirable. Bosc (Beurre Bosc), Comice, Clairgeau (Beurre Clairgeau), and Anjou are harvested either at one or two pickings. Hardy, where grown in any quantity, is almost always picked twice and sometimes three times. In general, the first picking is comparatively light, only the largest and most mature fruits being removed.

Hardy is the most important early commercial fall pear and is in demand on both domestic and foreign markets. It is shipped from the

Santa Clara Valley in earload lots immediately after harvest. Much of this fruit, however, passes through storage for precooling; and a portion may be held under cold-storage temperatures for one to three months. Winter Nelis and other late varieties may be stored for a considerably longer period, either at the point of production or in the eastern markets.

In districts where fall and winter pears are grown in rather limited quantities, primarily to extend the Bartlett season, the crop, with the possible exception of Winter Nelis, moves for the most part directly into the channels of trade.

NATURE AND EXTENT OF THE INVESTIGATIONS

The experimental work with the fall and winter varieties has been similar to that previously reported for the Bartlett. The firmness of the fruit picked on different dates during the harvest season, has been compared with the subsequent quality when ripe. Data have also been secured on the time in which each sample ripened, and the period during which it remained in good marketable condition.

The investigations, begun in 1928, have included tests with more than a dozen varieties. Chief attention, however, has been given to those shipped in largest quantity. These, listed in approximate order of importance,⁴ are Hardy, Winter Nelis, Comice, Easter Beurre, Clairegeau, Bose, Glou Moreceau, and Anjou. Most samples of fruit have been secured from the Santa Clara Valley; but, for the purposes of comparison, samples of one or more varieties have also been secured from the Carmel Valley, San Juan Bautista, Brentwood, Davis, Sacramento River, and Mayhews regions, and the Sierra foothill districts in Nevada, Placer, and El Dorado counties.

Collecting and Handling of Samples.—As far as possible, different districts were visited two or three times during the season, and samples of fruit were secured at the beginning of commercial harvest (or slightly before), at the height of the picking season, and again toward its close. A portion of the fruit was personally harvested from individual trees; but, with the work extending into a number of rather widely separated districts it became necessary to select some samples from commercial lots brought into the packing house.

Each sample of fruit contained 50 to 75 pears, which, after the beginning of commercial harvest, represented as nearly as possible the

⁴ Blue Anchor, March, 1931. California Fruit Exchange. Data obtained from the Shipping Pear Trade Association.

maturity of the fruit then being picked. Ten pears were selected for pressure-test determinations, their size and color having first been recorded. The remainder of the sample was then packed and transported by car, or in a few instances shipped, to the cold-storage plant at Davis. With the quicker-ripening varieties some of the fruit was held under room temperature for immediate ripening. Other parts of the same sample were held under a 50° F "transit temperature" for 11 days and then under a 32° F storage temperature from 6 to 16 weeks before ripening. Record was made of the number of days required for each sample to ripen, the quality when ripe, and the number of days the fruit remained in good marketable condition. The accompanying tables present summarized data on the different lots stored for a reasonably long period.

Determining Color and Firmness.—Color determinations were made by comparing the fruit with the standard color chart used for Bartlett pears. For greater accuracy and convenience in experimental work, the different shades of green or yellow were designated by number, No. 1 representing green, No. 2 light green, No. 3 yellowish-green, and No. 4 greenish-yellow to light yellow. When the color appeared to be between two shades, fractional numbers were used. With such varieties as Bosc and Winter Nelis, the russetting of the fruit often completely covered the green ground color and made difficult an accurate color comparison with the chart.

Firmness was ascertained with a tester measuring in pounds the pressure required to force a plunger point $\frac{5}{16}$ inch in diameter into the flesh of the fruit to a depth of $\frac{5}{16}$ of an inch.⁵ The average of 20 pressure-test readings, one taken on opposite sides of each of ten pears constituted the firmness of each sample. To insure greater uniformity and more accurate determination of firmness, the skin was first removed from the points tested.

Determining Dessert and Keeping Quality.—The dessert quality was determined by cutting and sampling several specimens on the day when they appeared to have reached prime eating condition. Keeping quality was determined by the number of days required for the fruit to ripen after harvesting or after removal from storage and the period during which it remained marketable after ripening.

⁵ Described in: Allen, F. W. Maturity standards for harvesting Bartlett pears for eastern shipment. California Agr. Exp. Sta. Bul. 470:21-27. 1929.

FACTORS INFLUENCING COLOR DEVELOPMENT

Fruits grown in different sections, and to some extent those grown in different orchards of the same district, show considerable variation in ground color, the development of blush, or the amount of russetting characteristic of the variety. Districts differ to a considerable extent in light intensity, in humidity, and in daily temperature variations, and these elements of climate, either singly or in combination, play an important part in the coloring of fruit.

Within individual orchards, variation in coloring may be caused or influenced by differences in soil, in the orchard management given the trees, in rootstock, or perhaps inherent differences within the variety itself. The Japanese rootstock has been observed to increase the yellow color of Bartlett pears,⁶ while quince stock has been observed to have a like effect upon Clairgeau and Hardy. With such varieties as Bosc and especially Winter Nelis, what is termed a variety is perhaps made up of two or more strains. With Winter Nelis, differences between these possible strains appear not only in the presence or lack of coloring and russetting, but in the relative size of the fruit. Although few fall and winter pears are characterized by high color, color changes are none the less important, being closely associated with ripening and in many instances with subsequent quality.

FACTORS INFLUENCING FIRMNESS AND RATE OF SOFTENING

Climate.—The factors influencing firmness are in part the same as those influencing color, for the two qualities are closely associated. Bartlett pears grown under high temperatures accompanied by low humidity were distinctly firmer than those grown under coastal influences. Although fall and winter varieties may show less influence of these climatic conditions than does the Bartlett, sectional differences apparently exist; and the relative firmness of several varieties grown in the Santa Clara Valley, in the interior valley sections, and in the Sierra foothills may be seen from the data in table 2 and from a comparison of the charts on softening, figures 1 to 3.

⁶ Allen, F. W. The texture and ripening of Bartlett pears as influenced by the rootstock. Proc. Amer. Soc. Hort. Sci. 26:325-327. 1929.

Although firmness of pears in one year may differ somewhat from that in another, seasonal variations, with late pears in the Santa Clara Valley at least, fall within a relatively narrow picking range; and the three-year averages of maximum and minimum figures given in table 2 show the fruit from this section to be harvested at lower pressures than that from other districts. A given picking pressure will naturally be reached earlier in some years than in others, according to the general earliness or lateness of the season.

TABLE 2

MAXIMUM AND MINIMUM FIRMNESS OF PEAR SAMPLES FROM DIFFERENT DISTRICTS DURING THE PERIOD OF COMMERCIAL HARVEST, AVERAGE OF SEASONS 1928-1930

District	Hardy		Comice		Anjou		Bosc		Clairgeau		Winter Nelis	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Santa Clara Valley.....	lbs. 11.2	lbs. 8.2	lbs. 11.6	lbs. 8.8	lbs. 14.2	lbs. 11.3	lbs. 13.8	lbs. 9.9	lbs. 15.1	lbs. 12.5	lbs. 16.6	lbs. 13.3
San Juan Bautista } Carmel Valley }	12.6	9.5	12.6	11.3	.....	.....	13.0	12.3	14.6	11.5	18.0	14.2
Sacramento River district.....	12.8	10.3	12.4*	11.3*	21.6*	13.7*	17.6	13.9	19.3*	14.2*	20.4	17.0
Davis.....	11.1	10.0	13.0	12.0	15.6	12.5	16.8	15.1	18.8	16.0	20.9	16.0
Newcastle-Auburn.....	12.1	11.6	12.0	9.1	18.0*	13.0*	18.5	15.3	18.0	13.6	19.5	15.5
Placerville.....	14.1*	11.2*	.....	.....	20.1*	13.9*	16.6*	14.5*	.....	.....	.....	.....

* For the 1928 season only.

The blushed side of a fruit gives a higher pressure-test reading than the opposite side, and a pear with a high blush is usually firmer than one without.

Heavily russeted fruit also has a tendency toward greater firmness, while intense heat may cause sunburn and an extremely hard texture of the flesh.

Rootstock.—Bartlett pears produced on Japanese rootstock (*Pyrus serotina*) were found to be firmer⁷ than those grown on French pear (*P. communis*) stock, while Clairgeau and Hardy pears have been observed to ripen earlier and be somewhat softer on quince stock than on the French pear root.

Size of Crop.—No definite experimental data now available show the influence of size of crop upon rate of softening in fall and winter pears. Hartman,⁸ using a relatively large number of samples of Bart-

⁷ Allen, F. W. The texture and ripening of Bartlett pears as influenced by the rootstock. Proc. Amer. Soc. Hort. Sci. 26:325-327. 1929.

⁸ Hartman, Henry. Studies relating to the harvesting and storage of apples and pears. Oregon Agr. Exp. Sta. Bul. 206:1-31. 1924.

lett from heavily and lightly loaded trees, found fruit from the former to be farther advanced. On the other hand Haller and Magness,⁹ working with apples in Virginia, report ripening (judged by color changes and time of dropping) to be hastened by a large number of leaves relative to the number of apples on the tree. In other words, a heavy crop of fruit retarded the ripening.

Partial Removal of Crop.—Hartman found the rate of softening of Comice and Anjou pears grown in the Rogue River Valley of Oregon to be retarded by the previous harvesting of a major portion of the crop. Where the most mature fruit is removed, the remainder will naturally require several days before being of texture equal to or softer than the earlier pickings. Frequently, too, some of the fruit allowed to remain on the trees until late in the season is smaller and poorer than that harvested earlier.

In these investigations a preliminary picking in and of itself has had no noticeable influence upon the subsequent rate of softening. Occasionally, however, late pickings of a variety have been as firm as one or more of the earlier pickings, or even slightly firmer. This condition has been noted in orchards where only a small proportion of the fruit had been previously removed. In these instances the texture of the flesh has apparently been influenced by prevailing high temperatures and possibly by a lack of sufficient available moisture to keep the cells of the fruit turgid.

FACTORS INFLUENCING OR ASSOCIATED WITH DESSERT QUALITY

Dessert quality in fruit depends upon the texture of the flesh and upon its chemical composition. These, in turn, are influenced by the locality and manner of growing the fruit, the time of harvesting, and the subsequent handling; also by the natural characteristics of the variety itself.

Soil and Climatic Conditions.—Although pears have a wide natural distribution, appearance and quality vary in fruit from different districts. Such variation is attributed to differences in soil, in temperature, in the relative humidity of the air, in the intensity of sunlight, or in some other climatic factor. The exact effect of soil type and of climatic conditions upon quality cannot be definitely stated, nor have the

⁹ Haller, M. H., and J. R. Magness. The relation of leaf area to the growth and composition of apples. Proc. Amer. Soc. Hort. Sci. 22:184-196. 1925.

optimum growing conditions been ascertained for the different varieties of pears. Apparently, however, late-ripening pears are not so well adapted to interior valley districts, with high summer temperatures, as to other parts of the state.

In general, pears are also better adapted to the heavier soils. Hartman,¹⁰ in his investigations with Bose pears in the Rogue River Valley of Oregon, reports that this variety when grown on the heavier types of soil is of better dessert quality than on lighter soils. This statement may hold for California also, though direct comparisons of the variety growing on different soils in close proximity to each other has not been made. Bose may be mentioned, however, as being decidedly variable in quality and is doubtless more exacting in its requirements than most other varieties.

Adequate Food and Water Supply.—Growing conditions unfavorable to normal development are usually reflected not only in the size of the fruit but in its quality. Magness,¹¹ studying the effect of size of crop upon the dessert quality in apples grown on ringed branches, found that at least 30 leaves per fruit were necessary to secure fair quality and that 50 leaves per fruit were preferable. Chemical analyses of Bartlett, Anjou, and Winter Nelis pears, also grown on ringed branches, with a varying number of leaves per fruit, led him and his associates¹² to conclude that the fruit grown with a larger leaf area had not only larger size but a higher sugar content, higher acidity, and on the whole a better and more characteristic flavor than fruit grown with a reduced amount of foliage.

The writer has observed that Bartlett pear trees lacking available soil moisture for any period of time may have this unfavorable condition reflected in fruit of inferior texture.

Time of Harvesting.—Extensive experimental work during the past few years has greatly emphasized the important relation between time of harvesting and dessert quality. Commercial orchardists and many others engaged in handling and marketing now recognize the mistakes of premature picking. Realizing also that picking may, with some varieties at least, be delayed so long as to shorten the life of the fruit

¹⁰ Hartman, Henry, J. R. Magness, F. C. Reimer, and M. H. Haller. Investigations on the harvesting and handling of Bose pears from the Rogue River Valley. Oregon Agr. Exp. Bul. 228:1-30. 1927.

¹¹ Magness, J. R. Relation of leaf area to size and quality in apples. Proc. Amer. Soc. Hort. Sci. 25:285-288. 1928.

¹² Magness, J. R., F. L. Overley, and W. A. Luce. Relation of foliage to fruit size and quality in apples and pears. Washington Agr. Exp. Sta. Bul. 249:1-26. 1931.

and to impair its shipping qualities, growers and shippers are primarily interested in determining the optimum stage of development for harvesting.

This rather indefinite stage of development has, by many trials, been rather definitely ascertained. All the usual picking indexes have been used, but changes in color and in firmness have proved to be most satisfactory.

Color.—Besides the change in the ground color of fruit, which occurs independently of sunlight and which is an index of maturity, the red color also has a quality value. Since some important varieties of late pears do not assume a red color or a blush, this factor of color is somewhat less important perhaps than with certain varieties of apples, apricots, plums, or grapes. Samples of Clairgeau, Comice, and Anjou possessing a good blush or a considerable red color have, however, had the highest flavor. Hartman¹³ reports that highly russeted Bosc pears are usually much spicier and sweeter at maturity than specimens with little or no russet.

Handling and Ripening.—The dessert quality of any fruit harvested considerably before being consumed depends not alone upon the grade of the fruit and its maturity when picked but upon its method of handling and ripening after picking. The later-ripening varieties of pears have exhibited best quality when promptly stored and held under low temperatures for from several weeks to several months and then removed to a temperature of 60 to 70° F for ripening.

MATURITY CHANGES AND TIME OF HARVESTING

The results of picking the different varieties of late pears at different stages of maturity in general resemble those secured with the Bartlett. Fruit picked prematurely is subject to shriveling or scald and is liable to possess a tough, spongy flesh of insipid if not undesirable flavor. The first commercial picking of most varieties failed to develop dessert quality equal to that of fruit allowed to remain on the trees one to three weeks later, and in numerous cases failed to show as good keeping quality. Fruit harvested at a stage of maturity compatible with good dessert quality will generally show, if carefully and properly handled, close to the optimum shipping and keeping quality. Harvest-

¹³ Hartman, Henry, J. R. Magness, F. C. Reimer, and M. H. Haller. Investigations on the harvesting and handling of Bosc pears from the Rogue River Valley. Oregon Agr. Exp. Sta. Bul. 228:1-30. 1927.

ing delayed until unusually late may be at the expense of dessert quality as well as shipping quality.

In these investigations there have been certain instances in which a very early picking was omitted and the first samples secured consequently had good quality. In other instances, fruit from a given orchard may first have been rated as good but subsequently as only fair. Although personal judgment may in part account for this reversal of quality, climatic conditions such as extreme heat may, more probably, have proved detrimental. Samples tested may, in addition, not always have been representative of the entire picking; or the grade of the fruit taken from commercial lots of the last picking may not always have equalled that of the former samples.

Occasionally some fruit will ripen with fair or marketable quality rather early in the season and never appear to improve thereafter, while that from other orchards may be of decidedly inferior quality throughout the season. There are therefore samples that show considerable variation in quality regardless of maturity, but these must be considered as exceptions to the rule.

General recommendations for harvesting the principal varieties of late pears are given in table 3. The summarized data upon which these recommendations are based are shown in part in tables 4 to 13.

TABLE 3

SUMMARIZED RECOMMENDATIONS ON COLOR AND FIRMNESS AT WHICH TO HARVEST
FALL AND WINTER PEARS

Variety	Color	Firmness as measured by pressure tester					
		Santa Clara Valley		Sacramento River district		Sierra foothill districts	
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
		<i>pounds</i>	<i>pounds</i>	<i>pounds</i>	<i>pounds</i>	<i>pounds</i>	<i>pounds</i>
Hardy.....	2	10.5	9.0	10.5-11.0	.....	11.5	.....
Howell.....	2	18.0	12.0	18.0	12.0	.....	.....
Bosc.....	2	13.5	10.0	15.0	12.0	15.0-16.0	.....
Clairgeau.....	3	13.0	11.0	14.0	11.0	15.0	11.0
Comice.....	2-2½	11.0-11.5	9.0	12.0	9.0	12.0-13.0	9.0
Anjou.....	2	13.5-14.0	11.0	14.0-15.0*	.....	14.0-15.0*	.....
Forelle.....	2	14.0-15.0	.....	.....	.....	.....	.....
Glou Moreau	1½-2	13.5	11.0	.....	.....	.....	.....
Winter Nelis.....	2	14.0	12.0	14.0-15.0	.....	16.0	.....
Easter Beurre.....	1½-2	16.0	.....	.....	.....	.....	.....

* If of a No. 3 color.

The influence of temperature upon the average time required for the different varieties to ripen is shown in table 15. Tables 4 to 13 show only the results secured when the fruit had been held at the usual

transit temperature—50° F—and subsequently for a period of from 6 to 16 weeks in storage at 32° F. With the later varieties at least, it was felt that these results would correspond to those from commercial shipments and that the quality might be judged more accurately after a storage period.

A brief summary of the softening and color changes in the different varieties, together with suggested picking practices, follows.

HARDY

Color Changes.—Hardy (Buerre Hardy) usually possesses either a rather clear green skin or one lightly covered with a thin brown russet. Color changes immediately before harvest may or may not be very noticeable, but as ripening progresses the deep-green color assumes more of a yellowish or frequently an olive-green shade. Disappearance of the dark-green color causes the russetting, when present, to become somewhat more apparent.

Softening.—Hardy has a very tender flesh and is the softest variety tested. Ten days to two weeks before ready for harvest, individual specimens of Hardy may test as high as 14 to 15 pounds; but a 12-pound maximum is more common. The usual rate of softening during the harvesting period is, as shown in figure 1, about 0.75 pounds in 10 days. In exceptional cases softening has been found to be as rapid as 2 pounds in 10 days, while, as illustrated for 1930, it was practically negligible in the Santa Clara Valley during the last two weeks of harvesting. During that season, the same condition was noted with samples of fruit secured from the Sacramento River, from the University Farm orchards at Davis, and from the Loomis-Newcastle district of Placer County. Between July 29 and August 14, 1930, Hardy pears from the Sacramento River district remained at a firmness of 11.0 pounds, while for 10 days after August 19, 1930, fruit from the University Farm orchard remained at approximately 9.5 pounds. The average firmness and the rate of softening in the Loomis-Newcastle district of Placer County during the last half of July were identical with those for Davis.

Recommendations for Harvesting.—According to samples picked at different stages of maturity over a period of three seasons, the most satisfactory picking pressure for the harvesting of Hardy pears is between 11.5 and 9.0 pounds. Fruit grown in the Santa Clara Valley is usually somewhat softer than that from the Sacramento River district or the Sierra foothills; and at the beginning of the picking season

TABLE 4

HARDY PEARS: RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED AND SUBSEQUENT DESSERT AND KEEPING QUALITY
(Samples held for 11 days at 50° F and 6 weeks at 32° F before ripening)

District	When picked		Time to ripen <i>days</i>	When ripe		Period marketable after ripening <i>days</i>
	Firmness <i>pounds</i>	Color index*		Condition	Flavor	
Santa Clara Valley and San Juan Bautista	{ 12.9-12.0	1½-2	4.3	Shrivelled, spongy, fruit remained green in color	Mostly poor	5.0
	{ 11.9-11.0	1½-2	4.0	Shrivelled, 50 per cent remained green in color	Poor to fair	5.5
	{ 10.9-10.0	2-2½	4.5	Slightly shrivelled to firm, depending on time of picking	Mostly fair to good	6.0
	{ 9.9-9.0	2-3	3.5	Slightly shrivelled to firm, depending on time of picking	Mostly good to very good	4.7
	{ 8.9-8.0	2-3	2.0	Mostly firm	Good to very good	3.0
Sacramento River	{ 12.9-12.0	1½-2	2.0	Shrivelled	Poor	1.0
	{ 11.9-11.0	1½-3	4.0	Slightly shrivelled	Poor to fair	5.5
	{ 10.9-10.0	1½-3	4.0	Slightly shrivelled	Fair to good, mostly good	4.3
Davis	{ 12.5†	1½-2	2.0	Shrivelled	Poor	.....
	{ 11.8†	2	4.0	Slightly shrivelled	Fair to good	12.0
	{ 10.8†	2-2½	4.0	Mostly firm	Good to very good	10.0
	{ 9.5	3-3½	6.0‡	Firm	Good to very good	15.0‡
Sierra foothills. (Loomis-Newcastle)	{ 12.9-12.0	1½-3	2.5	Slightly shrivelled	Fair to poor	5.0
	{ 11.9-11.0	2½-3	5.0	Mostly firm	Fair to very good, mostly good	5.0

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish-yellow to light yellow.

† Individual sample only.

‡ Fruit stored immediately at 32° F.

in the Santa Clara Valley a maximum pressure test of 10.5 pounds is recommended. Pears from this district may sometimes ripen with fair to good quality when averaging an 11.0-pound test, but usually not at the beginning of the season. In the Sacramento River area a firmness of 10.5 to 11.0 pounds is suggested for the beginning of harvest, while at higher altitudes the maximum may be 11.5 pounds (table 4).

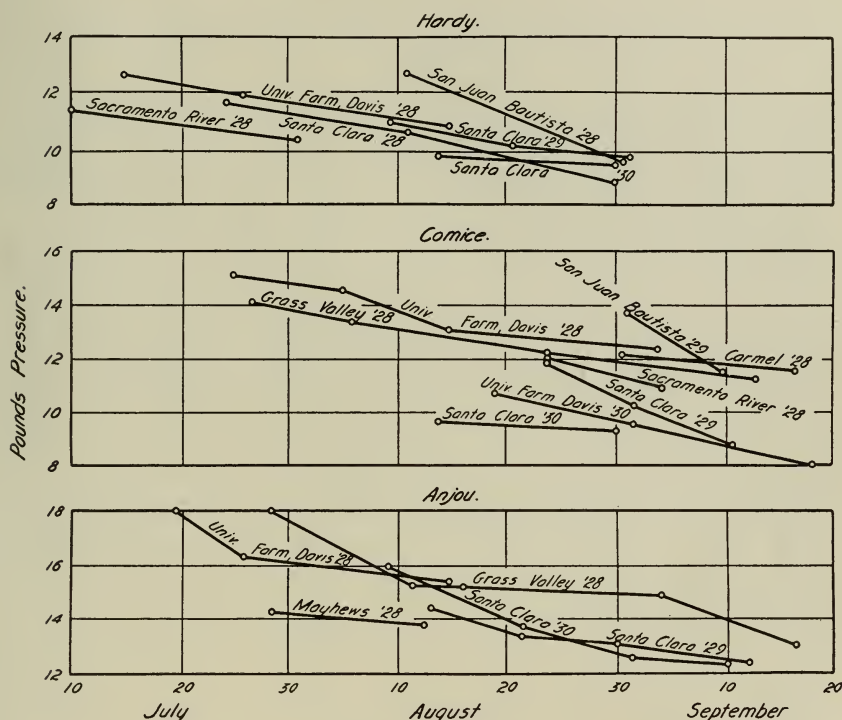


Fig. 1.—Rate of softening of Hardy, Comice, and Anjou pears from different districts during the seasons of 1928-1930.

In general, fruit allowed to remain on the trees until testing between 9 and 10 pounds possessed as good holding quality as that harvested extremely early. Some samples picked at a firmness between 7 and 8 pounds, held under a "transit" temperature of 50° F, and subsequently stored for 6 weeks at 32°, possessed good keeping quality and were marketable for a week or more after their removal from storage. Extremely late harvesting, however, is attended with some risk of premature ripening; and one should take extra care that such fruit is quickly cooled and is maintained under a low temperature until marketed.

TABLE 5

HOWELL PEARS: RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED AND SUBSEQUENT DESSERT AND KEEPING QUALITY
(Samples held for 11 days at 50° F and 8 weeks at 32° F before ripening)

District	When picked		Time to ripen	When ripe		Period marketable after ripening
	Firmness	Color index*		Condition	Flavor	
Santa Clara Valley	{ 19.5 18.5 17.5	{ 2 1½-2 2	{ 8 5 5	Firm	Fair to good	7
				Firm	Good	9
				Firm	Fair to good	7
				Firm	Fair to good	5
Davis	{ 19.0 18.0 13.0	{ 2 2½ 3	{ 6 8 5	Firm	Very good	5
				Firm	Good to very good	10
				Firm	Very good	5
				Firm	Good to very good	5
	7.5	3½-4	5	Firm	Good to very good	.....

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish-yellow to light yellow.

TABLE 6

ANGOULEME PEARS: RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED AND SUBSEQUENT DESSERT AND KEEPING QUALITY
(Samples held for 11 days at 50° F and 8 weeks at 32° F before ripening)

District	When picked		Time to ripen	When ripe		Period marketable after ripening
	Firmness	Color index*		Condition	Flavor	
Santa Clara Valley	{ 11.5 10.5	{ 2 2	{ 12 10	Firm	Fair	7
				Firm	Fair	8
				Firm	Good	11
				Firm	Good to very good	9
Davis	{ 11.5 10.5-10.0 8.5-7.5	{ 1½-2 2-2½ 2½-3½	{ 8 9 8	Firm	Good to very good	7

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish-yellow to light yellow.

Data on the samples collected at San Juan Bautista and at the University Farm indicate that a pressure test of between 9 and 10 pounds gave fruit of best quality, although in some seasons equally good quality may be secured relatively late with a somewhat higher pressure. In the latter cases, the skin had definitely changed from its original dark green to a noticeably lighter or a yellowish-green.

HOWELL

Howell pears lose their green color rapidly in ripening and may, under interior valley conditions, show a decided yellow before being harvested. Softening is likewise rapid after the fruit becomes yellow.

Samples collected in the Santa Clara Valley, between August 11 and August 20, 1928, at pressures of 19.5 to 17.5 pounds, ripened without shriveling and with fair to good quality (table 5).

Similar samples from the University Farm orchard at Davis, collected on August 5, 1928, at 19.0 pounds pressure, ripened with fair to good quality, whereas the sample collected 10 days later at 18.0 pounds, with more color, had very good quality when ripe. Fruit from that orchard, collected over a period of four weeks between August 19 and September 20, 1930, at pressures between 11.5 and 7.5 pounds, ripened with good to very good quality. The samples picked on the last date, although yellow and firm ripe, kept well in storage for eight weeks. Thus Howell pears may apparently be harvested over a relatively long period, the most satisfactory picking pressures ranging from 18 pounds down to 12 pounds.

ANGOULEME

Two samples of Angouleme (Duchesse D'Angouleme) from the Santa Clara Valley, having a pressure test of 10.5 and 11.5 pounds when delivered to the packing house, ripened with fair quality. Samples collected from the University Farm orchard at Davis over a period of 30 days in two different seasons, at pressures ranging from 11.5 to 7.5 pounds, all were good to very good when ripe. The riper fruit was superior for dessert purposes and, with the exception of the last picking, was equal in keeping quality to that picked earlier (table 6). From these few data, Angouleme, under Sacramento Valley conditions, appears to have a relatively long picking season, with pressures ranging from 11.0 to 8.0 pounds.

TABLE 7

BOSO PEARS: AVERAGE RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED AND SUBSEQUENT DESERT AND KEEPING QUALITY
(Samples held for 11 days at 50° F and 10 weeks at 32° F before ripening)

District	When picked		Time to ripen	When ripe		Period marketable after ripening
	Firmness	Color index*		Condition	Flavor	
	<i>pounds</i>		<i>days</i>			<i>days</i>
Santa Clara Valley and San Juan Bautista.....	16.5†	2	6.0	Shriveled, spongy.....	Fair.....	7.0
	15.0†	1-1½	11.0	Slightly shriveled.....	Poor to good, mostly fair.....	8.0
	13.9-13.0	2½	6.0	Mostly firm.....	Fair to good, mostly fair.....	8.0
	12.9-12.0	2½	6.9	Mostly firm.....	Fair to very good, mostly good.....	9.1
	11.9-11.0	2½	7.0	Firm.....	Fair to very good, mostly good.....	8.2
Carmel Valley.....	10.9-10.0	3	7.5	Firm.....	Fair to excellent, mostly fair.....	7.7
	9.9-9.0	3	5.7	Firm.....	Fair to excellent, mostly very good.....	8.7
	13.7†	2-3	7.0	Firm.....	Good.....	10.0
	12.5-12.0	3-4	5.5	Firm to slightly shriveled.....	Good.....	4.5
	16.5-16.0	2-2½	.....	Spongy, failed to ripen properly.....	Scalded when ripe.....	.....
Brentwood.....	16.9-16.0	1½-3	10.2	Slightly shriveled to firm, depending on color attained.....	Poor to good, mostly fair.....	5.2
Sacramento River.....	15.9-15.0	1½-3	14.0†	Mostly firm.....	Fair to good, mostly fair.....	4.0
	14.9-14.0	1½-4	9.0	Mostly firm.....	Mostly fair to good.....	5.4
	16.7†	1-1½	6.0	Spongy, imperfect ripening.....	Poor.....	.....
	15.2†	2-2½	6.0	Mostly firm.....	Good.....	4.0
	14.3†	3	13.0	Firm.....	Good.....	6.0
Mayhews..... (Sacramento County)	13.2†	3	12.0	Firm.....	Good.....	5.0
	17.0†	1½	.....	Spongy, green color and failed to ripen properly.....	.....	.....
	16.8†	2	12.0	Spongy.....	Fair.....	6.0
	14.6†	2	12.0	Firm.....	Good.....	8.0
	17.9-17.0	1½	13.0	Slightly shriveled.....	Fair to good, mostly fair.....	6.0
Sierra foothills..... (Perry-Newcastle)	16.5†	2-2½	10.0	Slightly shriveled.....	Fair.....	5.0
	15.5	3	10.0†	Firm.....	Fair to good, mostly good.....	6.5
	14.9-14.0	3½	7.0	Firm.....	Fair.....	6.0
	13.9-13.0	3½	6.0	Firm.....	Mostly fair.....	4.5
	12.9-12.0	4	5.5	Firm.....	Mostly fair.....	3.8
Sierra foothills..... (Auburn, Grass Valley, Placerville)	11.9-11.0	4	5.7	Firm.....	Fair to very good.....	3.3
	20.0†	1½	.....	Spongy—failed to ripen properly.....	.....	.....
	16.9-16.0†	3½	8.0	Firm.....	Good.....	5.0
	15.9-15.0	3	7.0	Firm.....	Good to very good.....	5.8
	14.9-14.0	3	3.0	Firm.....	Good to very good.....	7.5
	13.0†	3½	8.0	Firm.....	Good.....	9.0

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish-yellow to light yellow. † Individual sample only. ‡ Fruit stored immediately at 32° F.

BOSC

Color Changes.—The changes in color of Bosc (Beurre Bosc) before harvesting and the color when harvested are variable. In some instances the skin shows almost no russeting, and the dark-green color gradually changes into a greenish-yellow or yellowish-brown. Where heavy russeting is present, the prevailing color for some time before harvest is a light cinnamon-brown; little if any of the true ground color of the fruit may be evident. Between these two extremes are all degrees of green and yellow. Variation in the amount of russet present on the fruit has been observed both in different districts and between individual orchards of the same district.

Softening.—Bosc is somewhat firmer but more variable in texture than Hardy. A variation of several pounds is noted between different districts and between different seasons. The general rate of softening, however, is relatively uniform—0.75 to 1.00 pound each 10 days (fig. 2).

Recommendations for Harvesting.—The quality with which the samples of Bosc pears have ripened has also varied more than that of any other variety observed. The juiciness and richness usually expected in this pear have in many instances been lacking; and the expected gain in quality, usually found in the later pickings, has not always been discernible. Notwithstanding this variation, fruit picked extremely early will shrivel badly and become spongy in texture. The results secured (table 7), together with the opinions of growers and shippers, indicate that commercial pickings in the Santa Clara Valley and in coastal districts should be made at a firmness of between 13.5 and 10.0 pounds. The most suitable picking range for the Sacramento Valley sections is probably 15 to 12 pounds, but some districts in the Sierra foothill sections may possibly begin the harvesting of heavily russeted fruit as firm as 16 pounds. Except perhaps in districts liable to encounter strong winds and in orchards where an insufficient number of sprays have been applied to protect the fruit from late worm infestations, the harvesting of Bosc should not be rushed. Early dropping of the fruit is, under most conditions, confined to wormy or otherwise defective specimens. Some late-picked samples ripen somewhat sooner than those harvested during the earlier part of the season, but this earlier ripening is not always reflected in a correspondingly shorter period of marketability.

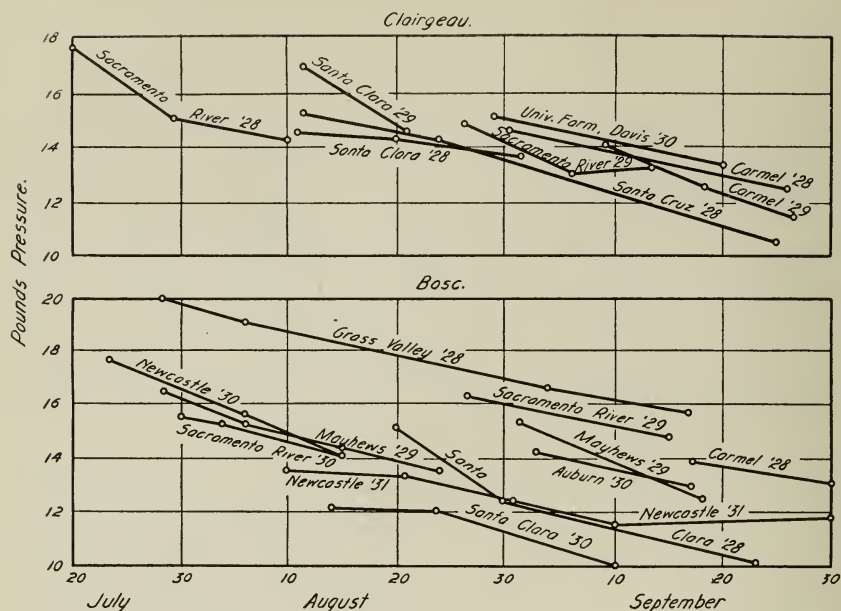


Fig. 2.—Rate of softening of Clairgeau and Bosc pears from different districts during the seasons of 1928-1931.

COMICE

Color Changes.—Color changes in Comice rather resemble those of Bartlett in that as the fruit begins to lose its original green color, the darker or russet-colored lenticels give the skin a somewhat speckled appearance. Not infrequently, color changes are rather marked in Comice; the skin may become distinctly yellowish, with the fruit showing some blush, before harvest.

Softening.—Comice also possesses a soft flesh similar to Hardy but slightly more variable in firmness and rate of softening (fig. 1). In 1929, a number of samples from the Sacramento Valley, the Sierra foothill districts, the Santa Clara Valley, and the San Juan Bautista districts softened as much as 2 pounds in 10 days. In 1930, several samples from the same orchards in the Santa Clara Valley softened only 0.5 pounds in a corresponding period. The first samples taken in 1930, however, were approximately 2.5 pounds softer than those in 1929.

Recommendations for Harvesting.—In the Santa Clara and Carmel valleys, the harvesting of Comice may begin when about 1 pound firmer than Hardy, or at 11.0 to 11.5 pounds. Fruit picked at 12.0 pounds

may ripen with satisfactory flavor but is liable to shrivel slightly when removed from storage or when ripe (table 8). Perhaps the ideal firmness for commercial harvest in the Santa Clara Valley is 10.5 pounds. When handled very carefully, Comice pears as soft as 9.0 pounds show good keeping quality; but unless cooled quickly after harvest they are liable to be considered overripe when received on the terminal markets.

Data on samples from the University Farm at Davis and from the Sacramento River district indicate that the fruit may be picked at 12 pounds. Pears from the higher altitudes ripened with good quality at 12 to 13 pounds. On the other hand, Comice from the interior valley and foothill areas can, apparently, be allowed to remain on the tree until testing as soft as 7 to 8 pounds and still be of good keeping quality. However, on account of the soft texture of Comice and its inability to withstand commercial handling without showing bruises and discoloration of the skin, commercial shipments from all districts should be harvested before reaching this degree of ripeness. The ideal color stage for harvesting Comice for eastern shipment ranges from light green to yellowish-green.

CLAIRGEAU

Color Changes.—When fully ripe, Clairgeau (Beurre Clairgeau) should be of an attractive yellow color, generally with a marked blush. Indications of this high color should be readily apparent before harvesting.

Softening.—The rate of softening of Clairgeau (fig. 2) is similar to that of Hardy and Comice, but the flesh is firmer and does not demand so much care in harvesting and handling.

Recommendations for Harvesting.—Early-picked Clairgeau pears from the Santa Clara Valley, testing 16 to 18 pounds, were of uniformly poor dessert quality. Late pickings with a slight yellowish-green color gave fair quality when testing as high as 14.5 pounds. Good quality was obtained only when the fruit had softened to 13 pounds or below and when the skin had a distinctly yellowish-green color when picked (table 9).

Fruit from the Carmel Valley and Santa Cruz Mountain districts ripened with little shriveling and satisfactory quality when testing as high as 15 pounds; but with the late season in these districts and the high color attained by the fruit, a pressure test of 13 pounds or lower is recommended.

Harvesting of Clairgeau from the Sacramento River districts should preferably not begin until the fruit tests 14 pounds. At Davis

TABLE 8

COMICE PEARS: AVERAGE RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED AND SUBSEQUENT DESERT AND KEEPING QUALITY
(Samples held for 11 days at 50° F and 8 weeks at 32° F before ripening)

District	When picked		Time to ripen	When ripe		Period marketable after ripening
	Firmness	Color index*		Condition	Flavor	
	<i>pounds</i>		<i>days</i>			<i>days</i>
Santa Clara Valley and San Juan Bautista	13 9†	2	6.0	Slightly spongy	Fair, slightly astringent	8.0
	12.9-12.0	2-3	5.5	Slightly shrivelled	Fair to very good, mostly good	5.8
	11.5†	2-3	6.0	Mostly firm	Good	8.0
	10.9-10.0	2½-3	5.5	Mostly firm	Fair to very good, mostly good	9.2
	9.9-9.0	3	2.0	Firm	Fair to very good, mostly good	10.3
	8.9-8.0	3	5.0	Firm	Fair to good	5.7
Carmel Valley	11.9-11.0	2-3	4.3	Mostly firm	Fair to good	6.4
Sacramento River	12.5†	2	5.0	Slightly shrivelled	Good	9.0
	11.5†	3	6.0	Firm	Very good	5.0
Davis	14.5†	1½	5.0	Spongy, green color	Poor to fair	12.0
	12.9-12.0	2	6.5	Firm	Good to very good	7.5
	9.9-9.0	2-3	8.5‡	Firm	Good to very good	8.5
	7.7	2½	6.0	Firm	Very good	7.5
Sierra foothills (Newcastle)	9.8†	3	7.0	Firm	Good	10.0
	6.7	4	5.0	Firm	Very good	10.0
Sierra foothills (Auburn, Grass Valley)	13.5-13.0	2½-3	4.5	Mostly firm	Very good	8.5
	11.9-11.0	2-3	3.5	Firm	Good	7.0

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish-yellow to light yellow.

† Individual sample only.

‡ Fruit stored immediately at 32° F.

TABLE 9
CLAIRGEAU PEARS: AVERAGE RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED
AND SUBSEQUENT DESSERT AND KEEPING QUALITY
(Samples held for 11 days at 50° F and 12 weeks at 32° F before ripening)

District	When picked		Time to ripen	When ripe		Period market-able after ripening
	Firmness	Color index*		Condition	Flavor	
Santa Clara Valley	pounds		days			days
	18.0†	2	.....	Spongy, tough, failed to ripen properly...	.....	.....
	16.0	2	.....	Spongy, tough, failed to ripen properly...	Poor to fair	7.7
	14.9-14.0	2	8.7	Slightly shrivelled to firm	Poor to good	9.3
	13.9-13.0	2-4	8.5	Mostly firm	Fair to good	11.5
Carmel Valley	12.0	2½	12.5	Firm	Fair to good	12.5
	11.5-11.0	3	13.0	Firm	Fair to good	.....
	15.5†	2	6.0	Slightly shrivelled	Fair to good	8.0
	14.0	2-2½	8.0	Firm to slightly spongy	Fair to good	8.0
	13.0†	2	8.0	Firm	Good	7.0
Santa Cruz Mountains	11.9-11.0	2½	8.0	Firm	Good to very good	6.0
	15.0†	2	11.0	Firm to slightly shrivelled	Fair	11.0
	14.3†	2	6.0	Firm	Good	9.0
	10.3†	red	3.0	Firm	Very good	7.0
	19.5-18.0	1½-2	5.0	Shrivelled, spongy	Poor	2.0
Sacramento River	16.9-16.0	2	9.5	Slightly shrivelled	Fair to good	7.0
	14.9-14.0	1½-3	9.0	Slightly shrivelled to firm	Fair to good	7.0
	13.9-13.0	3	7.5	Firm	Good to very good	7.5
	19.5-19.0	1-2	9.5	Firm to slightly shrivelled	Mostly fair	9.0
	14.9-14.0	2½	11.0	Firm	Fair to good	7.0
Davis	13.0†	2-2½	10.0	Firm	Fair	10.0
	21.9-20.0	1½-2	10.0	Spongy to firm, depending upon time of harvest	Poor to fair	3.5
	16.0†	2½	9.0	Firm	Fair to good	5.0
	13.0†	2½-3	9.0	Firm	Good	5.0

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish-yellow to light yellow.

† Individual sample only.

and in other localities under low-humidity and high-temperature conditions, fruit may in some seasons fail to soften properly before harvest. In such instances the pears should be allowed to become well colored before being picked.

A 15-pound pressure test is to be desired as a maximum. A limited number of samples from Placer County in 1928 indicated that relatively late pickings of Clairegeau with good color will ripen with satisfactory quality when testing as high as 22 pounds. This, however, is regarded as exceptional, and a test of 15 pounds or under with a yellowish-green color is recommended. Clairegeau harvested at 11 pounds has shown good keeping qualities and is less subject to scald than fruit picked earlier.

ANJOU

Color Changes.—Color changes in Anjou are readily noticeable; the ground color is distinctly altered by the time the fruit should be harvested. This color change also appears to be closely associated with the development of quality.

Softening.—Although the flesh of Anjou at the time of picking is relatively firm, being similar to Bosc, the rate of softening may be considerably more rapid. Figure 1 shows softening to be between 0.5 and 1.5 pounds for each 10 days.

Recommendations for Harvesting.—Most Anjou pears are picked when giving a pressure test between 14 and 11 pounds. A maximum of 13.5 to 14.0 pounds is recommended for the Santa Clara Valley. The fruit should show a decided lightening of the original green color. Eleven pounds appears to be a safe minimum at which to harvest the last of the crop and still have the fruit retain good keeping quality. When distinctly yellowish-green, fruit from the interior valleys and the Sierra foothill districts may be considered ready for the initial picking at a maximum of 14 to 15 pounds.

The dessert quality of Anjou has varied considerably according to individual orchards. Practically without exception, however, fruit picked during the latter half of the harvest period has been of better dessert quality than that picked at the beginning (table 10).

TABLE 10

ANJOU PEARS: AVERAGE RELATION BETWEEN FIRMINESS AND COLOR WHEN PICKED AND SUBSEQUENT DESSERT AND KEEPING QUALITY
(Samples held for 11 days at 50° F and 12 weeks at 32° F before ripening)

District	When picked		Time to ripen	When ripe		Period marketable after ripening
	Firmness	Color index*		Condition	Flavor	
	pounds		days			days
Santa Clara Valley	15.8†	2	8.0	Shrivelled	Poor	10.0
	14.9-14.0	2½	7.7	Slightly shrivelled	Mostly fair	8.5
	13.9-13.0	2½	8.5	Mostly firm	Fair to good	11.8
	12.9-12.0	2-2½	9.0	Firm	Fair to good, mostly good	9.8
	11.9-11.5	2	5.0	Firm	Fair to good, mostly good	13.0
Carmel Valley	12.0†	2½	7.0	Firm	Good to very good	12.0
Sacramento River	15.5	2-2½	10.5	Spongy	Poor to fair	6.0
Mayhews (Sacramento County)	14.5-13.5	2-3	10.0	Firm to slightly shrivelled	Poor to fair	8.3
Davis	19.0†	1½-2	11.0	Shrivelled	Fair	6.0
	16.5†	1½-2	10.0	Mostly firm	Fair to good	12.0
	15.0†	2-2½	8.0	Firm	Good	14.0
	12.0†	2½	5.0	Firm	Good	10.0
	9.8†	2-2½	5.0	Firm	Good	14.0
Sierra foothills (Penryn-Newcastle)	13.5-11.5	2½-3	.....	Firm	Fair to good	7.0
Sierra foothills (Grass Valley-Placerville)	20.0-17.0	1½	10.0	Shrivelled, spongy	Very poor	10.3
	16.0	2	10.0	Firm	Poor to fair	7.5
	15.0†	2-3	6.0	Firm	Good	10.0
	13.9-13.0	2-2½	4.0	Firm	Good to very good	12.5

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish-yellow to light yellow.

† Individual sample only.

FORELLE

Color Changes.—Well-grown Forelle pears when fully ripe are among the most attractive varieties grown. They should consequently be allowed to take on as much red color as possible before harvesting, with the ground color of a decidedly light green or even a yellowish-green.

Softening.—Data are too limited to state the general rate of softening for Forelle, but it is undoubtedly similar to the average for the other fall and winter varieties.

Recommendations for Harvesting.—The few samples secured indicate that 14 to 15 pounds might be considered a satisfactory picking pressure for Forelle grown in the Santa Clara Valley and that a slightly higher pressure might be justified in some other districts. All samples observed, however, shriveled somewhat after a period of 16 weeks in storage. While this change may have resulted in part from insufficient humidity, a slightly later harvesting would probably have increased both the storage and the dessert quality.

SECKEL

Limited tests with Seckel from the Sacramento River district and from the University Farm indicated that fruit picked from these districts the latter half of August at pressures of 18 to 15 pounds ripened with good quality. From 17 to 15 pounds is probably the optimum pressure for the interior valley and foothill districts; fruit from the Santa Clara Valley being slightly softer.

GLOU MORCEAU

Color Changes.—Except in the samples from the Carmel Valley harvested in October, color changes in Glou Morceau before picking were not marked. Most samples from the Santa Clara Valley had, however, changed somewhat from their original green color.

Softening.—Softening was likewise generally somewhat less rapid than in most varieties, averaging approximately 0.5 pound in 10 days (fig. 3).

Recommendations for Harvesting.—Although several samples of fruit in 1929 ripened with satisfactory quality when harvested at a pressure exceeding 14 pounds, 13.5 to 11.0 pounds is generally recom-

mended. Fruit showing a yellowish-green color and allowed to remain on the trees until October is likely to be of better quality at 14 to 15 pounds than that picked in August at a pressure of between 11 and 12 pounds. Early pickings are subject to scald and are liable to ripen imperfectly, with an astringent flavor. Some commercial pickings might possibly be delayed until the fruit tests below 11 pounds; it will then ripen with higher dessert quality and with little or no reduction in period of marketability (table 11).

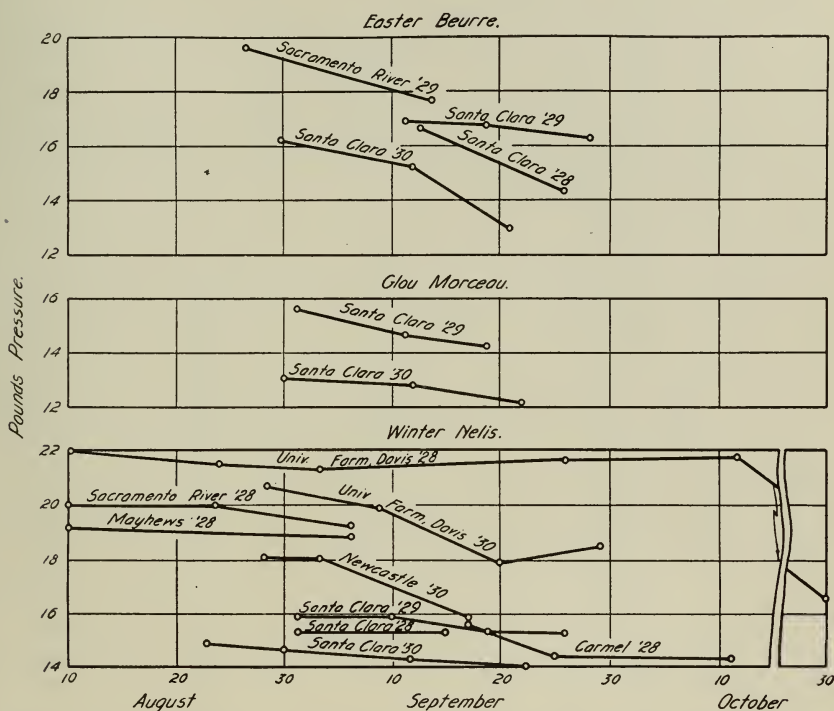


Fig. 3.—Rate of softening of Easter Beurre, Glou Moreceau, and Winter Nelis pears from different districts during the seasons of 1928-1930.

WINTER NELIS

Color Changes.—Winter Nelis pears are often so heavily russeted that changes in the ground color are scarcely discernible. When distinguishable, the ground color should have changed from dark green to light or yellowish-green before harvesting. Fruit picked in the dark-green color stage is liable to ripen imperfectly, with an insipid or astringent flavor.

TABLE 11
 GLOU MORCEAU PEARS: AVERAGE RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED
 AND SUBSEQUENT DESSERT AND KEEPING QUALITY
 (Samples held for 11 days at 50° F and 16 weeks at 32° F before ripening)

District	When picked		Time to ripen <i>days</i>	When ripe		Period market-able after ripening <i>days</i>
	Firmness <i>pounds</i>	Color index*		Condition	Flavor	
Santa Clara Valley and San Juan Bautista.....	15.9-15.0	2	9.3	Firm to slightly shrivelled	Fair to good	14.0
	13.9-13.0	2	11.8	Mostly firm	Mostly good	12.6
	12.9-12.0	1½-2	12.2	Firm	Mostly good	9.2
	11.9-11.0	2	11.5	Firm	Fair to good	11.0
Carmel Valley.....	15.0†	2-3	7.0	Firm	Good	10.0
	13.5†	2-3	7.0	Firm	Very good	16.0

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish-yellow to light yellow.

† Individual sample only.

Softening.—The softening of Winter Nelis (fig. 3) has been rather erratic, often showing little or no difference in firmness during the picking season. The most rapid softening occurred in 1930 with the samples of fruit from Newcastle and from the University Farm, which softened 2 pounds in 10 days. Fruit from the same trees at the University Farm two years earlier showed practically no softening until October 10, after which it softened very rapidly. A few pears remaining on the tree until November 6 gave an average pressure-test reading of 14.3 pounds. Fruit from the Santa Clara Valley was usually softer than that from other districts.

Recommendations for Harvesting.—The fact that Winter Nelis may not show marked softening changes until late in the season, and that firmness and dessert quality are not always closely correlated, leads one to conclude that this variety has a rather wide picking range and that the fruit may be harvested commercially over a considerable period of time. In general, however, the later pickings have shown the highest quality (table 12) and better fruit may be expected from some orchards by harvesting Winter Nelis somewhat later than has been customary.

In the Santa Clara and other coastal valleys, pears should remain on the trees until testing under 15 pounds, and most of the crop should be harvested at a pressure of 14 to 12 pounds.

Fruit from the Sacramento River district, picked at 17 to 18 pounds, has ripened with rather inferior quality, and it is doubtful if harvesting in this district should start earlier than in the Santa Clara Valley.

Sixteen to possibly 17 is suggested as a maximum pressure for the initial harvesting of Winter Nelis in the foothill districts.

At Davis, the firmness has varied considerably in different seasons. In 1928 good-quality fruit was secured when harvested in September or October at a pressure of 22 pounds, but in 1930 inferior fruit was obtained when picked at 18 pounds. Very firm pears should be allowed to remain on the tree until in danger of dropping.

In some instances late-picked samples have ripened more quickly than those picked earlier, but aside from a few individual lots, the period of marketability has not been materially reduced.

P. BARRY

Only a few samples of P. Barry have been held under observation, and as all but one of these shriveled and ripened with an insipid flavor they were apparently harvested too early. The ground color of the fruit had changed very little if any from its original shade of dark green,

TABLE 12

WINTER NELIS PEARS: AVERAGE RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED
AND SUBSEQUENT DESSERT AND KEEPING QUALITY
(Samples held for 11 days at 50° F and 12 weeks at 32° F before ripening)

District	When picked		Time to ripen <i>days</i>	When ripe		Period market- able after ripening <i>days</i>
	Firmness <i>pounds</i>	Color index*		Condition	Flavor	
Santa Clara Valley and San Juan Bautista.....	$\left\{ \begin{array}{l} 16.9-16.0 \\ 15.9-15.0 \\ 14.9-14.0 \\ 13.9-13.0 \\ 12.9-12.0 \end{array} \right\}$	$\left\{ \begin{array}{l} 1\frac{1}{2}-2 \\ 1\frac{1}{2}-2\dagger \\ 1\frac{1}{2}-2\dagger \\ 2\dagger \\ 2-2\frac{1}{2}\dagger \end{array} \right\}$	$\left\{ \begin{array}{l} 7.6 \\ 10.0 \\ 7.9 \\ 10.3 \\ 6.5 \end{array} \right\}$	$\left\{ \begin{array}{l} \text{Spongy to firm} \\ \text{Slightly spongy to firm} \\ \text{Mostly firm} \\ \text{Firm} \\ \text{Firm} \end{array} \right\}$	$\left\{ \begin{array}{l} \text{Poor to good, mostly fair} \\ \text{Poor to good, mostly fair} \\ \text{Fair to very good, mostly good} \\ \text{Fair to very good, mostly good} \\ \text{Good} \end{array} \right\}$	$\left\{ \begin{array}{l} 8.0 \\ 10.0 \\ 11.6 \\ 8.3 \\ 7.5 \end{array} \right\}$
Carmel Valley.....	14.5†	1½-2	10.0	Firm	Good	6.0
Sacramento River.....	17.5	2†	7.0	Shrivelled	Poor to fair	6.0
Mayhews..... (Sacramento County)	18.8†	2	14.0	Slightly spongy	Poor to fair	10.0
Davis.....	$\left\{ \begin{array}{l} 21.9-21.0 \\ 19.9-18.0 \\ 15.5\dagger \end{array} \right\}$	$\left\{ \begin{array}{l} 1-1\frac{1}{2} \\ 1\frac{1}{2}-3 \\ 2-3 \end{array} \right\}$	$\left\{ \begin{array}{l} 7.2 \\ 9.0 \\ 10.0 \end{array} \right\}$	$\left\{ \begin{array}{l} \text{Mostly firm} \\ \text{Mostly firm} \\ \text{Firm} \end{array} \right\}$	$\left\{ \begin{array}{l} \text{Poor to very good} \\ \text{Poor to good, mostly fair} \\ \text{Very good} \end{array} \right\}$	$\left\{ \begin{array}{l} 12.5 \\ 5.3 \\ 3.0 \end{array} \right\}$
Sierra foothills..... (Loomis-Newcastle)	$\left\{ \begin{array}{l} 18.0-17.5 \\ 16.9-16.0 \\ 15.9-15.0 \\ 14.0-13.5 \end{array} \right\}$	$\left\{ \begin{array}{l} 2\dagger \\ 3-4\dagger \\ 2\dagger \\ 3\dagger \end{array} \right\}$	$\left\{ \begin{array}{l} 11.7 \\ 9.0 \\ 7.3 \\ 6.0 \end{array} \right\}$	$\left\{ \begin{array}{l} \text{Firm} \\ \text{Firm} \\ \text{Firm} \\ \text{Firm} \end{array} \right\}$	$\left\{ \begin{array}{l} \text{Fair} \\ \text{Fair to good} \\ \text{Fair to good, mostly good} \\ \text{Good to very good} \end{array} \right\}$	$\left\{ \begin{array}{l} 9.2 \\ 7.5 \\ 8.0 \\ 9.0 \end{array} \right\}$

* No. 1, green; No. 2, light green; No. 3, yellowish-green; No. 4, greenish yellow to light yellow.

† Moderate to heavy russet largely obscuring the ground color.

‡ Individual sample only.

and the pressure-test readings were between 15 and 17 pounds. A late sample harvested at Carmel on October 13 with an average pressure of 10 pounds ripened with good to very good quality. Picking at a pressure intermediate between these extremes or at an approximate pressure of 12 to 14 pounds is apparently the optimum range.

EASTER BEURRE

Color Changes.—Easter Beurre pears are frequently harvested before they show any change in ground color. While color changes in this variety are not great, the fruit is best harvested after turning light green.

Softening.—Fruit from the Santa Clara Valley and the Sacramento River district softened from 0.5 to 1.0 pound in 10 days (fig. 3).

Recommendations for Harvesting.—Samples from the Santa Clara Valley indicate that Easter Beurre should be harvested when not firmer than 16 pounds (table 13). A limited number of samples from the interior valley and foothill districts show that late-picked fruit may be from 1 to 2 pounds firmer. In general, it is believed that if harvesting of this variety is delayed somewhat, better dessert quality would be secured without any loss in keeping quality.

INFLUENCE OF SHIPPING AND STORAGE TEMPERATURES ON THE RATE OF RIPENING AND PERIOD OF MARKETABILITY OF PEARS

The temperature to which deciduous fruits are subjected after harvest is recognized as the most important single factor influencing their time of ripening and their period of marketability. Changes in color and firmness of some of the more important fruits, as influenced by temperature, have been described in several previous publications.¹⁴

Tests on Bartlett pears held at 52° and 43° F have shown that ripening, as measured by softness, begins considerably earlier with fruit held

¹⁴ Allen, F. W., J. R. Magness, and M. H. Haller. The relation of maturity of California plums to shipping and dessert quality. California Agr. Exp. Sta. Bul. 428:1-41. 1927.

Magness, J. R., H. C. Diehl, and F. W. Allen. Investigations on the handling of Bartlett pears from Pacific Coast districts. U. S. Dept. Agr. Tech. Bul. 140:1-27. 1929.

Allen, F. W. Physical and chemical changes in the ripening of deciduous fruits. Hilgardia 6:13. 1932.

TABLE 13

EASTER BEURRE PEARS: AVERAGE RELATION BETWEEN FIRMNESS AND COLOR WHEN PICKED
AND SUBSEQUENT DESSERT AND KEEPING QUALITY

(Samples held for 11 days at 50° F and 16 weeks at 32° F before ripening)

District	When picked		Time to ripen	When ripe		Period market- able after ripening <i>days</i>
	Firmness <i>pounds</i>	Color index*		Condition	Flavor	
Santa Clara Valley.....	{ 18.9-18.0	1-2	<i>days</i> 8.5	Slightly shrivelled	Poor to fair	12.5
	{ 17.9-17.0	1½-2	7.2	Mostly firm	Poor to fair	10.6
	{ 16.9-16.0	2	7.7	Mostly firm	Poor to very good, mostly fair	11.0
	{ 15.9-15.0	2	6.5	Mostly firm	Fair to good, mostly good	12.0
	{ 14.9-14.0	1-2	7.5	Firm	Fair to very good	9.5
	{ 13.9-13.0	1½	7.0	Firm	Good	15.0
Sacramento River.....	{ 12.0†	1	8.0	Firm	Fair to good	13.0
	{ 19.5†	2	4.0	Slightly shrivelled	Poor	11.0
	{ 17.5†	2	5.0	Firm	Good	16.0
Davis.....	{ 18.0†	1	3.0	Shrivelled	Poor to fair	11.0
	{ 16.5†	1½-2	9.0	Firm	Good	18.0
Sierra foothills. (Newcastle)	18.0†	3½	7.0	Firm	Good	21.0

* No. 1, green; No. 2, light green; No. 3, yellowish green; No. 4, greenish-yellow to light yellow.

† Individual sample only.

at 52° than with that held at 43°, and that the latter can be held twice as long as fruit ripened under a temperature of 52°. Ripening at 36° was also approximately twice as rapid as at 31°.

TABLE 14

THE SOFTENING OF PEARS UNDER TEMPERATURES OF 32° AND 50° F, 1929

Variety	Firmness when picked	Amount of softening			Time stored at 32° F
		After 11 days at 50° F	After 11 days at 50° F and 6-16 weeks at 32°	From end of 11 days at 50° F to end of storage at 32°	
	<i>pounds</i>	<i>pounds</i>	<i>pounds</i>	<i>pounds</i>	<i>weeks</i>
Hardy.....	{ 11.1 10.5	{ 2.6 4.5	{	{	{ 6
Comice.....	{ 12.4 11.0 10.5	{ 3.6 2.1 0.7	{ 7.0 5.3	{ 4.9 4.6	{ 8
Bosc.....	{ 12.6 12.3	{ 2.5 1.0	{ 6.1 4.4	{ 3.6 3.4	{ 10
Anjou.....	{ 13.7 12.6 12.5	{ 1.3 0.8 1.8	{ 6.3 3.0 3.2	{ 5.0 2.2 1.4	{ 12
Clairgeau.....	{ 17.1 14.4	{ 0.7 -0.4*	{ 1.2 1.5	{ 0.5 1.5	{ 12
Glou Morceau.....	{ 14.7 14.2	{ 1.2 1.2	{ 0.8 2.3	{ -0.4* 1.1	{ 16
Forelle.....	{ 15.3 14.7	{ 1.5 1.5	{ 3.4 2.7	{ 1.9 1.2	{ 16
Winter Nelis.....	{ 15.7 15.9 15.3 15.2	{ 0.5 1.2	{ 4.7 2.8 4.1 2.4	{ 1.3 2.9	{ 12
Easter Beurre.....	{ 16.9 16.4	{ 0.3	{ 2.1 1.1	{ 1.8	{ 16

* Failure to show softening resulted from a slight sponginess of the flesh.

Table 14 illustrates the average rate of softening for several lots of fall and winter pears held under a temperature of 50° F during an 11-day "transit" period and during subsequent storage at 32°. Under 50° "transit" temperatures, Hardy, Comice, Bosc, Anjou, and Forelle soften most rapidly. Clairgeau, Winter Nelis, and Easter Beurre show only slight softening. Softening of Clairgeau is often difficult to determine because of a slight shriveling and toughness of the flesh.

The higher initial rate of softening for the earlier of the fall and winter pears is important in determining the length of their season; results on Hardy, Comice, Bosc, and Anjou show that these continue to soften more rapidly after being placed in 32° F storage than do such varieties as Glou Morceau, Winter Nelis, and Easter Beurre.

Samples of late-picked Hardy softened much faster at 50° F than did lots from the same orchard picked two weeks previously. Late-picked fruit of other varieties generally becomes ripe sooner after harvest than that picked early, but the difference is not nearly so marked as with the Hardy.

Table 15 shows the time required for different varieties of fall and winter pears to become ripe at a temperature of 65 to 70° F after being held for 11 days under top-of-car temperatures, after storage at 32° following the above "transit" period, and after immediate and continuous storage at 32°. Hardy was stored for 6 weeks; Howell and Comice 8 weeks; Angouleme and Bosc 10 weeks; Anjou, Clairegeau, and Winter Nelis 12 weeks; and Forelle, Glou Morceau, Easter Beurre, and P. Barry 16 weeks. With the earlier-ripening varieties, ripening was found to be less rapid for the lots of fruit held continuously for the above periods of time at 32° than for lots held only 11 days at 50° F. In all varieties tested, ripening was considerably less rapid when the samples were held continuously at 32° than when they had first been kept for 11 days at 50° and then stored at 32°. The fruit was also generally more crisp and of better appearance when not subjected to an 11-day period at 50°.

Some lots of fruit were held continuously at 70° F after harvest. Ripening at this temperature was little or no more rapid than when the fruit was previously held for a 10 to 12-day "transit" period at 50°. In both instances the flesh of the later varieties tended to become tough and spongy rather than to soften normally, a fact indicating that the true winter pears should have a relatively long holding period under storage temperatures before being transferred to a higher temperature for ripening. Although some varieties will ripen fairly successfully under cold-storage temperatures, removal from storage to a temperature of 60° to 70° will usually result in better dessert quality. Hardy and Bosc do not ripen satisfactorily at low temperatures.

The general ripening behavior, under a temperature of 65° to 70° F of the varieties listed in table 15 was as follows:

Hardy.—Hardy pears ripened very successfully in 5 to 6 days immediately after an 11-day "transit" period at 50° F. They may also be ripened at 70° immediately after harvest but are liable to be somewhat shriveled and spongy unless held under relatively high humidities.

TABLE 15

INFLUENCE OF TEMPERATURE ON THE RATE OF RIPENING AND THE PERIOD OF
MARKETABILITY OF PEARS, AVERAGES 1928-1931

Variety	Number of samples averaged	Period of storage at		Time to ripen at 65°-70° F after storage	Period marketable		Condition when removed from storage
		50° F	32° F		After ripening	Total from storage	
		<i>days</i>	<i>days</i>	<i>days</i>	<i>days</i>	<i>days</i>	
Hardy.....	{ 17	11	0	5.4	6.3	11.7	Mostly firm
	{ 35	11	31	4.0	6.4	10.4	Slightly shrivelling to slightly spongy
	{ 19	0	42	6.9	7.5	14.4	Mostly firm
Howell.....	9	11	45	6.0	7.5	13.5	Firm
Comice.....	{ 19	11	0	8.1	7.7	15.8	Firm
	{ 53	11	45	5.1	7.8	12.9	Mostly firm
	{ 21	0	56	8.7	9.9	18.6	Firm
Angouleme.....	{ 3	11	0	13.7	9.0	22.7	Firm
	{ 8	11	59	8.2	8.2	16.4	Firm
	{ 4	0	70	11.2	7.2	18.4	Firm
Bosc.....	{ 70	11	0	7.1	5.6	12.7	Firm with some slight shrivelling around stem
	{ 66	11	59	7.7	5.6	13.3	Mostly slightly shrivelled at stem end
	{ 41	0	70	11.9	7.2	19.1	Mostly firm
Anjou.....	{ 16	11	0	10.1*	13.7	23.8	Firm
	{ 35	11	73	8.2	11.4	19.6	Slight shrivelling or sponginess on 50 per cent of samples
	{ 17	0	84	12.7	10.5	23.2	Firm
Clairgeau.....	{ 11	11	0	11.2†	9.7	20.9	Firm
	{ 37	11	73	8.5	7.7	16.2	Firm to slightly spongy, mostly according to maturity when picked
	{ 11	0	84	12.5	10.2	22.7	Firm
Winter Nelis....	{ 11	11	0	12.8	8.4	21.2	Firm
	{ 85	11	73	8.7	10.2	18.9	Mostly firm, some slight shrivelling
	{ 27	0	84	10.4	7.9	18.3	Firm
Forelle.....	6	11	101	8.3	9.0	17.3	Firm
Glou Morceau	{ 4	11	0	19.2	5.7	24.9	Firm
	{ 25	11	101	10.8	12.0	22.8	Firm
	{ 8	0	112	14.2	7.8	22.0	Firm
Easter Beurre	{ 8	11	0	.....‡	.....	.....	.....
	{ 36	11	101	7.5	13.2	20.7	Firm to slightly spongy
	{ 13	0	112	9.0	14.5	23.5	Firm

* Represents 75 per cent of the samples. The remaining early-picked samples required 20 to 30 days to ripen.

† Early-picked samples failed to ripen. ‡ All samples became spongy and failed to ripen properly.

After 11 days at 50° and 6 weeks at 32° samples ripened in 4 days, as compared with 7 days required for similar lots put directly into 32° storage after harvesting. The total period of marketability was 10 and 14 days respectively. When held continuously at 32° until removed for ripening, the fruit was slightly more crisp than when previously held for 11 days at 50°.

Howell.—The ripening of Howell was confined to lots stored for 6 weeks at 32° after being held for 11 days at 50° F. The average time for these samples to ripen after removal from storage was 6 days, and they remained marketable for 7 days after ripening.

Comice.—After being kept at “transit” temperature—50° F—for 11 days and under 32° storage for 45 days, Comice pears required about 5 days to become ripe and were marketable for a total of 13 days. Most of the samples were removed from storage in firm condition and ripened with good quality. Comice also ripened well immediately after 11 days at 50°. The time required to ripen after this period was 8 days, while the fruit had a total period of marketability of 16 days. Samples held continuously at 32° for 8 weeks required nearly 9 days to ripen and had a total marketability period of 18 to 19 days.

Angouleme.—After an 11-day “transit” period at 50° F, Angouleme required 2 days longer to ripen (13 as compared with 11 days) and remained marketable 4 days longer than fruit held continuously at 32° for 10 weeks. Angouleme requires somewhat longer time to ripen than the varieties previously mentioned. The fruit ripened immediately after the shipping period showed no shriveling and possessed good quality.

Bosc.—Bosc pears were very successfully ripened at 65° to 70° F after a period of 11 days under a temperature of 50°. The fruit was mostly firm but showed some slight shriveling around the stem. Samples picked after midseason ripened fairly satisfactorily in 17 days when kept continuously at 70°. Some, however, showed considerable differences in quality when the ripening period was thus forced. Samples of Bosc, held for 8½ weeks at 32° in addition to an 11-day period at 50°, required practically the same length of time for ripening as others held for only the 11-day period at 50°—7 to 8 days in each instance. Twelve days were required for comparable samples to ripen after being held continuously for 10 weeks at 32°; this fruit was marketable for a total of 19 days, in comparison with 12 to 13 days for the samples previously held at 50°. It was also of firmer texture.

Anjou.—Anjou pears failed to ripen very satisfactorily either after 11 days at 50° F or when held continuously at 70°. In the former instance, about three-fourths of the samples ripened in 10 days, whereas

the other 25 per cent ripened with considerable shriveling in 20 to 30 days. Fruit held continuously at 70° required at least 20 days for ripening. Samples held continuously for 12 weeks at 32° ripened in 12 days and had a total marketable period of 23 days, as compared with 8 days required to ripen and 19 days of marketability for the fruit held at 50° for 11 days. Anjou showed slight shriveling in the latter case but was firm when held continuously under low temperatures.

Clairgeau.—Early-picked samples of Clairgeau failed to ripen after 11 days at 50° F, while the later-picked samples ripened in 11 to 12 days. A portion held continuously at 70° ripened with rather poor to fair quality in 18 days. Those held for 12 weeks at 32° showed a keeping quality much superior to that of samples previously held at 50°. The flesh of Clairgeau has a tendency to become rather tough and spongy, particularly in early-picked samples.

Winter Nelis.—Winter Nelis may be successfully ripened after being held only 11 days at 50° F but requires a ripening period of 12 to 14 days. Fruit held continuously at 50° for 4 weeks was found to be in prime eating condition when removed from this temperature, and most of the samples had ripened with good to very good quality. Samples held for 10½ weeks at 32° after an 11-day "transit" period at 50° ripened in 8 to 9 days—1 or 2 days sooner than those held continuously at 32°—but the total period of marketability under these two conditions was practically the same.

Forelle.—Forelle pears, held for 14½ weeks at 32° F after 11 days at 50°, required an average of a little over 8 days to ripen and were marketable for 9 days thereafter. Attempts to ripen this variety immediately after 11 days at 50° were not very successful, most of the fruit showing some shriveling and being of tough texture.

Glou Morceau.—The ripening of Glou Morceau pears immediately after 11 days at 50° F was fairly successful, although the time required was the greatest for any variety observed—19 days. All efforts to ripen the samples held continuously at 70° after harvest resulted in failure. This variety requires a relatively long ripening period. Fruit held at 32° after the "transit" period at 50° ripened in 11 days or 3–4 days sooner than that held continuously at 32°. The total marketable period from the time of removal from storage was practically the same for the two lots. Glou Morceau showed no appreciable shriveling except when held continuously at 70°.

Easter Beurre.—Easter Beurre is another variety which ripens best when held over a rather long ripening period. Attempts to ripen this variety under a temperature of 65–70° F immediately after harvest and

after an 11-day "transit" period at 50° resulted in failure. After a period of 16 weeks in storage at 32° the fruit still required 9 days to become ripe and remained in marketable condition for two weeks thereafter.

P. Barry.—No attempts were made to ripen *P. Barry* until after it had been held in storage for a total of 16 weeks. After this storage period two weeks under a temperature of 65–70° F were required for the samples to ripen. Most of the fruit showed slight sponginess when ripe.

VALUE OF PRECOOLING

Growers of fall and winter pears are not always agreed as to the necessity of precooling. The earlier varieties, particularly the Hardy, are in considerable demand for immediate consumption and, in order to gain time and save expense, are frequently shipped without precooling. Later varieties generally go into storage at or near the points of production before being shipped.

Although precooling does not guarantee good arrival of pears shipped long distances, it does remove much of the risk in connection with premature ripening, when fruit is packed at relatively high temperatures, or when temperatures in transit are brought down slowly. Not only will precooling tend to retard ripening under such conditions and permit a longer holding period after arrival at destination, but the fruit will usually be more crisp in texture. Table 15, giving the averages of numerous tests with the more important varieties, shows the results of ripening fruit immediately after 11 days at 50° F and furnishes a comparison between the rate of ripening, the keeping quality, and the general condition of comparable samples stored immediately and continuously at 32° and those held under a "transit" temperature of 50° for 11 days before storage. These methods of handling are similar to those when fruit is precooled and continuously held under low temperatures and when it is shipped without initial cooling. Fruit cooled quickly required a longer period to ripen in all varieties but Winter Nelis and Glou Morceau. The immediate cooling resulted in a longer period of marketability.

To secure the maximum advantages of precooling, fruit should be placed under ice as rapidly as good commercial handling will permit and cooled to below 40° F. If possible, the precooled fruit should then be loaded into well-cooled cars without being exposed to the outside air. When precooling is carried out at a plant not at the trackside or when the fruit after precooling is loaded into the holds of ships, some exposure to outside temperatures is necessary; but it should be reduced to the minimum, and unnecessary delays avoided.

INFLUENCE OF THE STORAGE PERIOD ON THE TIME REQUIRED TO RIPEN AND ON THE PERIOD OF MARKETABILITY

Since ripening is not entirely prevented by cold-storage temperatures, the length of time pears are held in storage materially influences their period of marketability. Table 16 illustrates the results secured with Hardy, Comice, Bosc, Anjou, and Winter Nelis pears held for the

TABLE 16

INFLUENCE OF THE LENGTH OF STORAGE PERIOD ON THE TIME REQUIRED TO RIPEN
AND ON THE PERIOD OF MARKETABILITY OF PEARS

Variety	Location	Date picked	Firm- ness when picked	Storage period		Time to ripen after storage	Period market- able after ripening	Total period market- able
				at 50° F	at 32° F			
			<i>pounds</i>	<i>days</i>	<i>weeks</i>	<i>days</i>	<i>days</i>	<i>days</i>
Hardy	Santa Clara	Aug. 14, 1931	8.8	{ 11 11	6 12	2 1	8 5	10 6
Hardy	Santa Clara	Aug. 14, 1931	8.0	{ 0 0	6 12	9 9	8 4	17 13
Comice	Auburn	Aug. 14, 1928	11.6	{ 11 11	6 9	6 2	10 6	16 8*
Comice	Santa Clara	Aug. 29, 1930	8.6	{ 0 0	8 12	10 9	8 4	18 13
Bosc	Sacramento	Aug. 15, 1928	14.3	{ 11 11	8 12	12 2	6 3	18 5
Anjou	Newcastle	Aug. 13, 1930	13.5	{ 0 0	12 22	13 7	9 5	22 12
Anjou	Newcastle	Aug. 15, 1930	11.5	{ 0 0	12 22	11 6	9 6	20 12
Winter Nelis	Santa Clara	Sept. 1, 1931	15.8	{ 11 11	10 20	8 7	8 8	16 15
Winter Nelis	Santa Clara	Sept. 9, 1931	14.7	{ 11 11	10 20	6 7	12 9	18 16

most-customary storage periods. Hardy pears cooled within a few hours after harvesting and held continuously at 32° F for 6 and 12 weeks required 9 days to ripen in each instance; but the longer storage period reduced by half the number of days during which the fruit remained marketable after ripening. Similar samples, stored for the same periods

but previously held for 11 days at 50° (car temperature), showed similar differences in the relative number of days the fruit was marketable after ripening. The period required to ripen was reduced to 1 and 2 days. The results with Comice, Bosc, and Anjou show more marked differences between the length of storage period and the time of ripening than were found with the Hardy. The keeping quality of late-ripening varieties such as Winter Nelis was but little affected by a storage period of 20 weeks.

TABLE 17

INFLUENCE OF LENGTH OF STORAGE PERIOD ON THE TIME REQUIRED TO RIPEN
AND ON THE PERIOD OF MARKETABILITY OF PEARS*

Variety	Days held at 32°†	Days to ripen	Days to become valueless	Cause of failure
Hardy.....	{ 80 133	4 4	9 9	Wilt, scald
Bosc.....	{ 116 164	9 4	17 9	Wilt, rot and scald
Comice.....	{ 120 161	5 5	12 8	Scald and rot
Angouleme.....	{ 96 147	5 1	13 4	Scald and rot
Anjou.....	{ 133 197	9 3	19 9	Wilt, rot, scald, internal breakdown
Winter Nelis.....	{ 160 215	4 0	19 10	Wilt, rot, some scald
Easter Beurre.....	{ 110 205	10 0	20 6	Penicillium, wilt, rot
Glou Morceau.....	{ 144 192	10 2	21 5	Wilt, breakdown
Forelle.....	{ 180 242	4 2	15 10	Wilt, penicillium, rot
P. Barry.....	{ 185 244	8 2	19 11	Penicillium, wilt

* From Overholser, E. L., and L. P. Latimer. The cold storage of pears, California Agr. Exp. Sta. Bul. 377: 1-56, 1924.

† The figures given here were considered respectively the optimum and the maximum storage periods for the variety.

The influence of longer holding periods on the rate of ripening and period of marketability is shown by table 17. These data,¹⁵ collected over a period of several seasons, likewise show that the time required for

¹⁵ Abridgment of data from: Overholser, E. L., and L. P. Latimer. The cold storage of pears. California Agr. Exp. Sta. Bul. 377: 1-56. 1924. (Out of print.)

Hardy to become ripe was no less after 133 days in storage than after 80 days. The number of days each of the two remained marketable was also judged to be the same. With all other varieties shown, the period of marketability was materially reduced by the maximum storage periods.

The present investigations have not aimed to determine the maximum number of days the fall and winter varieties of pears may be held at cold-storage temperatures. Varietal and seasonal differences, possible differences in the keeping quality of the same variety from different localities, the general type of handling the fruit receives, and the time elapsing between harvesting and storing, are all important factors which determine its storage life.

The storage periods given for the varieties shown in table 17 indicate what Overholser and Latimer considered to be average optimum and maximum holding periods for pears secured over a number of years from the Santa Clara Valley, Niles, and Davis. These periods, translated into calendar dates, would be: Hardy, November 9 to December 31; Howell, November 15 to December 9; Bosc, December 22 to February 8; Anjou, December 24 to February 26; Angouleme, December 3 to January 23; Comice, January 3 to February 14; Easter Beurre, January 3 to April 7; Glou Morceau, February 6 to March 26; Winter Nelis, March 1 to April 25; Forelle, March 15 to May 17; P. Barry, March 22 to May 20.

In connection with these dates attention should be called to the statement of Overholser and Latimer that the fruit was carefully handled and for the most part was placed under temperature within 6 hours after harvesting. They also define "optimum storage period" as the latest time of removal which gave best results in flavor and keeping quality after being taken from storage. The commercial grower and shipper should consider this optimum period as more important than the maximum storage period, which is the time beyond which the fruit is liable to become soft, wilted, or decayed.

Hartman,¹⁶ observing winter pears grown in the Rogue River Valley of Oregon and stored in the eastern markets, states: "Bosc may be held until the Christmas holidays, Comice until the middle of January, Anjou until the last of March, and Winter Nelis until the last of April." He adds, however, that under present methods of handling only a small part of the crop should be held until these dates.

Pentzer and his associates¹⁷ in the United States Department of Agriculture give relative storage periods for several varieties of pears when

¹⁶ Hartman, Henry. Investigations relating to the handling of Rogue River Valley pears on Eastern markets. Mimeo. Rpt. Also published in Blue Anchor (published by California Fruit Exchange) 8(No. 9):16-18 and 26-35. Sept., 1931.

¹⁷ Pentzer, W. T., J. R. Magness, H. C. Diehl, and M. H. Haller. Investigations on the harvesting and handling of fall and winter pears. U. S. Dept. Agr. Tech. Bul. 290:1-30. 1932.

held at the shipping point and in terminal markets. Although varying considerably between seasons, their suggested storage periods at point of production are similar to those given above. A slightly shorter storage period is recommended for Comice. When shipped without precooling and subsequently stored in the terminal markets, the recommended storage periods for the earlier-ripening varieties, such as Hardy and Comice, are reduced from a period of three to four months to one month or less.

The writer's results with a number of samples of Hardy, secured from the Santa Clara and San Juan Bautista districts and having a pressure test of only 9 to 10 pounds when picked, indicate the possibility of holding this variety in storage for 5 to 6 weeks after shipping even when not precooled. Samples held for 11 days under a temperature of 50° F, and then for 5 to 6 weeks at 32°, required on the average 4 days to ripen after removal from storage. The fruit retained a good dessert quality but in some instances lacked crispness. It remained marketable for 6 days after ripening. When portions of several of the above samples had been held at 32° for 12 weeks after the period of 11 days at 50°, the fruit was ripe or nearly so when removed from storage and remained marketable from 3 to 7 days.

Averages of the data in table 8 likewise show that nonprecooled Comice from the Santa Clara Valley, testing between 11 and 8 pounds when picked, may be kept in storage 8 weeks after being held for 11 days under shipping temperatures (50° F) and will then still require on the average 4 days to ripen, with an additional 8 days' marketing period. However, the fruit gave an average pressure test of only 4 pounds upon removal from storage, with some lots testing only 3 pounds or softer. Such fruit would be considered rather too ripe even for local markets. Soft Comice shipped without precooling had therefore best be offered to the trade immediately. Individual samples of Comice testing 8.6 and 9.6 pounds when picked have been held continuously at 32° for 12 weeks and have remained marketable for 13 and 14 days respectively after removal from storage.

Bosc held in storage 10 weeks after the period of 11 days at 50° F kept satisfactorily. A few samples of Winter Nelis held for 4½ months at 32° after an 11-day period at 50° F still retained a satisfactory keeping quality after removal from storage although the fruit was not crisp. All samples of Forelle, Glou Morceau, Easter Beurre, and P. Barry were stored approximately 16 weeks after being kept for 11 days at 50°.

STORAGE TROUBLES AND CAUSES OF DISCARD IN PEARS

Numerous physiological or fungus troubles may shorten or terminate the life of fruit either in storage or afterwards. Of these the most important are internal breakdown or core decay, surface breakdown, shriveling or wilting, scald, and penicillium and other rots.

Internal breakdown of the flesh—a soft, brown condition around the core—renders useless a large percentage of Bosc, Howell, and Hardy pears, together with a good proportion of the Comice and Winter Nelis varieties.

Surface breakdown, noticeable as soft, brown spots on the surface of the pear, is particularly prevalent in Bosc. Such spots may occur over any part of the fruit, softening and rotting around the stem being very common. Comice pears show spots lighter in color and more watery in appearance than those on Bosc, while Winter Nelis pears frequently display numerous small, brown, decayed spots, often called “pinhole” rot.

Shriveling, caused either by the fruit being too immature when harvested or by a lack of humidity in the storage rooms, is commonly encountered, but is more noticeable in some varieties than others. Early-picked Hardy, Comice, Anjou, and Forelle have shown rather severe shriveling; Bosc is subject to shriveling on the neck of the fruit even when properly picked and held under storage conditions satisfactory for most varieties.

Scald is particularly noticeable on Clairgeau, Comice, Hardy, and Anjou; but when fruit is not picked too early nor held too long scald is usually not serious.

Penicillium or blue mold frequently attacks fruit with punctured skin, fruit that has been stored too long, or under unfavorable storage conditions.

DISCUSSION

During past years there has been a tendency to harvest some varieties of fall and winter pears too early, just as in the case of the Bartlett variety. Such premature picking may have been for the purpose of filling orders by a given date or because the proper maturity for harvesting was difficult to determine. Color changes in late pears are frequently not marked, and softening of the flesh is relatively much less than in the Bartlett. Picking standards like those now used for harvesting Bartlett pears are therefore less easily applied to the late varieties, and correlations between color, firmness, and quality are not always so positive. Regardless of some exceptions found, however, the measurement of color and firmness changes is considered a valuable aid to one's judgment in determining proper harvesting dates.

In some districts experimental data are limited or even entirely lacking, and some slight variations may have to be made in the picking recommendations to fit individual cases. However, such instances will probably be few, and there will be little fruit which cannot be satisfactorily harvested within the suggested pressure-test ranges.

In order to make sure that any given variety is ready to harvest, picking might well be delayed until some individual specimens are at least a pound under the maximum pressure test suggested, for some others are always picked which will increase the average of the sample.

Firm fruit harvested after midseason may ripen with good quality, whereas fruit of the same degree of firmness several weeks earlier would have been only fair to poor. This fact was noticed in several instances with Bose, Comice, and Anjou during the 1930 season. When it is desirable to harvest the crop early, two pickings or more are advisable, only the larger and more mature specimens being removed at the initial picking. Aside from some further increase in size of the individual pears, the second picking will in nearly all cases be of better dessert quality.

Maximum pressures given represent the maximum firmness of the flesh at which most samples picked early in season have ripened without shriveling and with fair marketable quality, whereas the minimum pressures, at which best quality is obtained, represent approximately the softest fruit considered desirable for long-distance shipment.

Although color and softening changes are considered the most important indexes of maturity, and although well-matured fruit is essential to good quality, maturity alone does not account for the tender flesh or

pleasing flavor in pears. Aside from the factors previously presented, some lots of fruit apparently possess certain intangible and inherent characteristics not found in others. This fact has been particularly noticeable in Bosc and Winter Nelis from certain orchards. Of all pears observed, Bosc has proved the most variable in quality.

Where harvested at proper maturity, carefully handled, and cooled without delay, fall and winter pears should be shipped with little or no difficulty to almost any domestic or foreign market. The conditions surrounding the fruit in transit are, however, largely beyond the control of the grower or shipper; and, unless these are suitable, fruit loaded in prime shipping condition may prove disappointing to the receiver.

In general, fall and winter pears possess good storage qualities, and a certain proportion of the crop of some varieties should be held until late in the winter. Attempts to keep any sort beyond its natural marketing season are, however, to be discouraged. Observations and studies on trade demand indicate that the consumer is always interested in new fruits as they come in season and that the last of any fruit offered, even though still of fair marketable quality, finds only a limited demand.

SUMMARY

The results of harvesting fall and winter pears at different stages of maturity have resembled those secured with the Bartlett variety. Fruit harvested when immature may fail to ripen properly, or will ripen with poor quality and be subject to shriveling and to scald. Pears allowed to remain on the tree too long before harvesting, quickly become ripe and exhibit poor storage or shipping quality.

Determination of proper maturity for harvesting to secure good storage and shipping quality combined with good dessert quality has often been rather difficult, no single index for picking having proved satisfactory.

Although color and firmness changes in fall and winter pears before harvesting are less marked and are subject to the same factors that influence Bartlett pears, they do supply a valuable index of maturity.

Color changes in some districts and in some orchards are more pronounced than in others; but regardless of this variation, fruit harvested before showing some change in its original ground color will almost invariably fail to develop its optimum color, flavor, and texture when ripe. Not infrequently such fruit fails to ripen at all, only becoming shriveled and spongy, with a tough flesh of astringent flavor.

Inseparable from color changes in the skin of the fruit is the initial softening of the flesh. Pressure tests made at intervals to determine the degree of firmness are therefore a second most important aid to an intelligent decision regarding the development of the fruit. Pressure tests must, however, be properly made and must be interpreted in relation to color changes and in the light of influencing factors such as climate, rootstock, and size of crop.

Pears grown under coastal influences usually have less color and a slightly softer texture than those grown under higher temperatures and lower humidities. Suggested minimum color requirements and maximum and minimum pressures for harvesting the more important varieties appear in table 3, page 12.

Dessert quality is made up of numerous factors; but fruit harvested at or near the minimum pressure recommended, after showing a marked change in ground color, will usually ripen with good to best flavor.

The rate of ripening for pears after harvesting and the distance they can be transported are greatly influenced by the rate of initial cooling and by the temperature under which they are stored or shipped.

Late pears ripen best after a period in storage but should be removed from storage in advance of the time desired for use and ripened at a temperature of 60° F or above.

Internal and surface breakdown, shriveling, scald, and fungus rots are the chief causes terminating the storage life of pears.

ACKNOWLEDGMENTS

Appreciation is here expressed to numerous growers and shipping associations for their interest and cooperation in these investigations.